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Moving forward in implementing green infrastructures: Stakeholder perceptions of opportunities and obstacles in a major North American metropolitan area

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ABSTRACT

Urbanization poses both challenges and opportunities for the management of urban ecosystems globally. In the Greater Montreal Area (GMA), a major North American urban area where green infrastructure (GI) implementation is in its early stage, there are challenges in maintaining provision of ecosystem services due to urban expansion and climate change impacts. In response, stakeholders in the GMA are trying to further integrate the GI concept into planning practices and have participated in focus groups to discuss various approaches to implementing the GI concept. This paper addresses stakeholder perceptions of the opportunities and obstacles related to natural ecosystem management in the GMA. We discuss the way in which participants perceive the prospect of the GI concept to influence discourse and policy about environmental planning. We found plural perspectives on GI yet there was a broad consensus regarding problems in bringing planning tools in line with socio-ecological processes. This research provides a novel contribution by showing how the concept of GI informs narratives about metropolitan green space and environmental planning. The narratives of most research participants emphasised: 1) that efforts to protect and enhance the urban ecosystem should be approached within a coherent social and ecological framework at the scale of the metropolitan area, and 2) that GI planning needed to rely on collaborative and participatory approaches to enhance ecosystem services at all scales of the GMA.

1. Introduction

The concept of green infrastructure (GI) is increasingly popular among urban policy makers and planners worldwide who are faced with the multiple challenges raised by urban expansion and climate change (Baptiste et al., 2015; Emmanuel and Loconsole, 2015; Horwood, 2011). Most definitions of GI emphasise that it was introduced as a planning concept to improve "urban green space systems as a coherent planning entity" (Tzoulas et al., 2007, p. 169, citing Sandström, 2002). The coherence in planning to insure quality and quantity of interconnected and multifunctional green spaces is what we retain as the central aspect of this concept (Tzoulas et al., 2007; Benedict and McMahon, 2006). Although definitions vary somewhat depending on context and objectives, GI is well integrated in discourse on urban planning by many groups in developed countries that promote an integrated and participatory vision of green space management at the scale of metropolitan areas (Lovell and Taylor, 2013). Case studies provide contrasting narratives about the ways in which GI informs stakeholders involved in urban planning. According to some, GI often conflicts with more traditional urban development approaches focused on functionalist[1] planning criteria (Ahern, 2013). For others, the focus on infrastructure in GI resonates with pre-existing planning rationales, appearing both useful and applicable within ongoing bureaucratic processes (Cowell and Lennon, 2014; Rydin, 2010). The Greater

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[1] According to the dominant theory of functionalist urban planning, functions such as residence, work and leisure were treated as discrete elements and the zoning of these functions in the city insured their separation. The functionalist stance usually involves orthogonal planning so as to anticipate the needs and requirements of the different groups of users (Attoe and Logan, 1989).

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Montreal Area (GMA) offers a useful complement to existing case studies because discussions of GI are at a relatively early stage. Despite some attention to ecological connectivity, there is limited integration of the GI concept in official documents at the metropolitan scale, and stakeholders have only recently mobilized to discuss coherent planning of GI at the GMA scale (Bissonnette et al., 2017; Dupras et al., 2015). This is in contrast to jurisdictions where GI is well integrated in policies, such as in the GI and Biodiversity Strategies of the European Union (Čivić and Jones-Walters, 2014; Raymond et al., 2017).

Although discussion about ways to integrate the GI concept into planning practices at the GMA scale is relatively new, urban sprawl and ecosystem degradation have been major issues in recent decades (Dupras and Alam, 2015; Nazarnia et al., 2016). Loss of natural environment is a widespread concern in the GMA, and many stakeholders have become involved in the debate over the best approach to move forward with the development of GI (Dupras et al., 2015; David-Suzuki Foundation and Nature Action Québec, 2012). Even though significant efforts have been initiated by the City of Montreal (Di Marino and Lapintie, 2017), the GMA faces numerous challenges in the implementation of regional scale governance for environmental planning. This is also due to the fragmented governance in the GMA (Boudreau et al., 2006; Dupras et al., 2015). As such, the GMA case has global significance, in so far as it resonates with other metropolitan areas that also are early in the process of mobilizing GI in planning discourse and policy, while facing complex governance issues (Cowell and Lennon, 2014).

The potential of the GI concept to shape environment planning policies can usefully be analysed in the framework of a discourse coalition: "the ensemble of a set of story lines, the actors that utter these story lines, and the practices that conform to these story lines, all organized around a discourse." (Hajer, 1993, 47; Horwood, 2011). A discourse coalition rests on bottom-up collaborations that foster the emergence of a policy narrative that can translate into dominant institutional practices. In this context, our paper seeks to better understand how residents and stakeholders in the GMA tell their stories of opportunities and constraints for GI planning. Our paper is based on two workshop events that gathered researchers and practitioners in the field of urban ecosystem management and planning, along with citizens with an interest in GI. Focus groups were organized and participants asked to discuss their views of the potential for GI to help develop and enhance the provision of ecosystem services in the GMA.

Working with transcripts from the workshops and with a review of relevant literature, we analyze how stakeholders perceived opportunities and obstacles to the implementation of GI planning policies in the GMA. More generally, we discuss the potential of the GI concept to influence policies about regional scale environmental planning in major urban regions. We briefly review literature on GI as a participatory process with the capacity to shape policy for urban ecosystem management, and then present and analyze the data about GI perspective in the GMA that was collected during our two workshops. In our analysis, we build on previous research that touched on some of the obstacles encountered in the attempt to promote the development of GI (Byrne et al., 2015; Dupras et al., 2015; Matthews et al., 2015). More precisely, our analysis shows that stakeholder narratives can be organized around two main categories: 1) potential for integrating green infrastructures within planning tools; and 2) issues of collaboration and public participation in the implementation of green infrastructures in planning processes. Finally, we discuss the potential of the GI concept to influence policies that improve multifunctional planning within an integrated governance framework.

2. Green infrastructure as a participatory approach?

This research distinguishes between GI as a concept, and GIs as a large spectrum of practices in urban environmental planning. Although this distinction is often blurred in narratives, we are mainly interested in GI as a concept that can influence coherent environmental planning at the scale of the GMA. According to the theory of discourse coalition, coherent GI planning can become institutionalized in policies and practices by fostering a discourse with sufficient rhetorical power that "central actors are persuaded by or forced to accept…" a GI perspective (Hajer, 1993, p. 48). As stated by Shapiro (1981, 130), such a discourse can "establish norms for developing conceptualizations that are used to understand a phenomenon". The concept of a discourse coalition has the potential to organize efforts to affect policy changes despite there being a plurality of sometimes conflicting interests and values in play (Fischer, 2003, 102). Studies indeed affirm that GI perspectives can become embedded in planning practices through a storyline that reconciles different interests and values (Horwood, 2011, 967). For example, GI would have become integrated within planning practices in Dublin, Ireland, when a discourse coalition emerged among planning practitioners and allied professionals (Cowell and Lennon, 2014, 273).

The GI perspective on planning draws together a wide array of initiatives driven by a variety of stakeholders (Amati and Taylor, 2010; Evans and Freestone, 2010), a contrast to older green belt initiatives that have been criticized for their arbitrary boundaries and organization around a single function (i.e. forest conservation, agriculture, fresh water provision, etc.). As a result, centrally planned green belts have become less socially acceptable (Amati and Taylor, 2010; Thomas and Littlewood, 2010). Building a discourse coalition in support of GI perspectives is more consistent with contemporary participatory approaches to urban planning and multifunctional land use. This shift from top-down zoning approaches to bottom-up approaches can be related to a renewed emphasis on public participation to facilitate reconciliation of plural interests and values (Allmendinger, 2017, 144). The GI concept presupposes just such an approach responsive to a range of environmental, social and economic constraints and opportunities (Evans and Freestone, 2010; Lennon, 2015a).

Concepts such as GI tend to provide urban planners with integrative and operative planning concepts that move beyond dichotomies between urban and natural areas to enhance ecosystem services (Erixon et al., 2013). Some metropolitan experiences show that GI planning is compatible with map-based representations managed with existing planning tools (Cowell and Lennon, 2014). Moreover, the notion of infrastructure in GI is usually considered to be sufficiently broad to allow an explicit link to economic development policy, which can highlight the economic benefits of urban ecosystem management (Horwood, 2011). The decision processes involved with GI naturally tend "…to identify and secure multifunctional, connected areas of green space, predicated on their ability to deliver environmental, social, and economic benefits" (Cowell and Lennon, 2014, p. 265). Yet the GI concept does not prescribe specific means to achieve these benefits, which are often open to social deliberation through participatory processes.

Because of its multifunctional characteristics and the multiple benefits sought, GI planning is usually based on enlarged participatory processes including a broad range of stakeholders (Čivić and Jones-Walters, 2014; Mabelisa and Maksymiukb, 2009; Madureira and Andresen, 2014). In many urban settings, GI includes a large array of related initiatives by both government and civil society that can act synergistically, such as green roofs, small-scale conservation projects and ecological networks (Taylor et al., 1995; Yokohari et al., 2000). The plural, participatory dynamic involved in building a discourse coalition on GI initiatives within metropolitan areas often leads to policy enhancing multiple ecosystem services such as urban heat island mitigation and rainwater management (Thomas and Littlewood, 2010; Wright, 2011). To help expand this potential breadth, recent research seeks to better map out the plurality of meanings and values attributed to ecosystems in GI planning (Kati and Jari, 2016; Raymond et al., 2017). In this way, the social processes underlying bottom up initiatives such as local ecological corridors can be better understood to scale up ecosystem service provision and conservation.

Although the GI concept has emerged out of renewed attempts to reconcile the interests of representatives, urban planners and professionals from the broader civil society, reconciliation of these diverse views is not without difficulties. According to Naumann et al. (2011), the success of GI in terms of biodiversity conservation and ecosystem functions[2] ultimately depends on both the design of specific GI projects and on the direct participation of residential and commercial land owners, along with elected municipal officials (Baptiste et al., 2015). Matthews et al. (2015) highlight issues that cause urban planners to question the efficacy of the GI concept, notably 1) ambiguities in conceptualizing GI and 2) difficulties integrating GI within existing planning tools and processes. Roe and Mell (2013) criticize the GI concept as lacking in clarity, appropriateness and deliverability. But as previously discussed, it is precisely the plurality of values that creates the potential to overcome these obstacles and facilitate reconciliation of interests in a broad consensus. However, despite the belief that the private sector and civil society should play a dominant role in decisions regarding GI, the capacity to institutionalize GI initiatives through a coherent framework remains decisive in their implementation (Baptiste et al., 2015; Hostetler et al., 2011; Young and McPherson, 2013).

These contrasted views demonstrate the importance of a context-based analysis to understand the meanings attributed to GI and their potential to be taken up in policy and improve natural ecosystem management at the scale of an urban area. Therefore, it is important to better understand in this early stage of implementation of GI in the GMA, how norms and values about ecosystem management are expressed by diverse stakeholders, and whether a coherent, broad-based story-line or discourse emerges. Although GI has only recently drawn serious attention by urban planners and professionals in the GMA, there is some appreciation for the potential of GI to improve natural ecosystem management. However, most planners and environmental professionals express serious concerns about the feasibility of a regional scale environmental planning approach in the GMA. Studies show that constraints to ecosystem service provision improvement through the implementation of GI in the GMA are largely related to sociopolitical factors (Bissonnette et al., 2017; Dupras et al., 2015). Previous research, however, do not provide any clear indication regarding the potential of GI to inform discourse and planning policy to further its implementation. Hence, a major goal of this article is to fill this gap in knowledge by addressing how stakeholders might come to appreciate the potential of the GI concept when it has not yet been institutionalized in planning practices.

3. Region presentation: Greater Montreal Area

The GMA is centered around the City of Montreal on the island of Montreal, which accounts for nearly half of the regional population in an agglomeration of 82 municipalities with a total population of almost 4 million inhabitants in 2017 (CMM, 2015) (Fig. 1). The GMA population is expected to increase by 12.44% by 2031 (CMM, 2015). A recent study shows that the increase in urban sprawl has accelerated dramatically in Montreal in the last 30 years (Jaeger and Nazarnia, 2016; Nazarnia et al., 2016). Over 90% of the land in the area is privately owned. The municipalities that constitute the GMA display major differences in terms of natural environment endowment. For instance, municipalities have a forest canopy cover ranging from less than 1% to almost 90% (CMM, 2011). In the GMA, prime agricultural land is subjected to real estate speculation despite having protected status since 1978 (Fig. 1). Agricultural land has undergone sustained decline over the last few decades, while production intensification has also had negative impacts on ecosystem service provision by farmlands (Bélanger and Grenier, 2002; Dupras et al., 2016; Dupras and Alam, 2015). Within the GMA, 58% of the land falls under agricultural zoning and 64% of the forest cover is under agricultural zoning. Cultivated land in the GMA is largely dominated by intensive cereal, oilseed cultivation and market gardening (CMM, 2016c).

Natural ecosystems in the GMA are dominated by temperate deciduous forests and are among the most biodiverse and productive in the province of Quebec (Doyon et al., 1998; Meilleur et al., 1994). However, these forests have been highly transformed and degraded by land-use during the last two centuries, are highly fragmented, and associated wetlands have been reduced significantly (Bissonnette et al., 2016; Bissonnette et al., 2017; Dupras and Alam, 2015; Pan et al., 1999; Simard and Bouchard, 1996). Moreover, the expansion of cultivated land at the expense of forests has led some municipalities to enforce by-laws forbidding further reduction in forest cover on private land (Beaudin, 2003; Sokpoh, 2010). In this context, it is understandable that some elements often associated to the concept of GI has recently been actively promoted by prominent environmental organizations and emphasised in key planning documents (David-Suzuki Foundation and Nature Action Québec, 2012; CMM, 2013, 2016a; Dupras et al., 2015). The Quebec Association of Planners also dedicated a journal issue to GI (*Association des urbanistes du Québec* 2016). In sum, Montreal provides an interesting case study of a large metropolitan area with a complex and fragmented administrative structure that has relatively recently considered the potential of GI as an operative planning concept.

Official planning documents of the Montreal Metropolitan Community (MMC) do not yet explicitly refer to GI, although they seek to provide a regional framework for natural environment management. Created in 2001, the MMC was conceived as a strategic planning authority with jurisdiction over territorial planning, the environment and other fields in socioeconomic planning (Boudreau et al., 2006). As a steering structure for collaborative governance among the 82 municipalities of the region, the MMC plans for different features of environmental management. As such, its main reference document, the Metropolitan Land Use Planning and Development Plan (PMAD) 2012–2017, aims to reserve 17% of total GMA land under protection as GI. All regional county municipalities (RCM) – Regional administrative units in Quebec – and municipalities, must comply with certain standards when they prepare their own urban and land use plans (CMM, 2016c). However, despite these standards and the specific regulations that exist in each municipality of the GMA, many stakeholders have expressed concerns about the actual capacity and political will to implement adequate GI in GMA. In fact, these stakeholders have pointed out the difficulty of environmental management to effectively maintain ecosystem integrity and biodiversity while being socially acceptable to most groups of users (Dupras et al., 2015). Hence, to better understand and move toward resolution of these concerns, we organized discussions among diverse stakeholders to assess the potential of GI to further improve processes for environmental planning within a coherent framework for the GMA.

4. Methodology: data collection and analysis

We organized focus groups among various stakeholders in two occasions. The first workshop took place on 24–25 October 2015 and involved 17 university researchers (referred to as FG-1) familiar with GI and planning in the GMA. The researchers broke into 3 focus groups to discuss the best ways to achieve a proposition that was decided during the event through online voting: “An effective GI network shall integrate both natural and semi-natural ecosystems and vegetated structures. This network shall be effective at multiple scales, multifunctional and managed by local communities”.

A second workshop organized jointly by researchers, planners from the MMC, and staff from the David Suzuki Foundation was held during the Greater Montreal Natural Infrastructure Summit (*Le Sommet sur les infrastructures naturelles du Grand Montréal*) on June 16–17, 2016

[2] Ecological functions refer to processes that take place in ecosystems such as carbon sequestration and water infiltration, some of which may be considered as ecological or ecosystem services to human communities (Goldstein, 1999).

Table 1
Primary occupation declared by participants.

Occupation:	N
Biologist	15
Engineer	6
Environmental management	8
Municipal administration	7
Urban planners	4
Environmental NGO	4
Other civil society	7
Private sector	9
Academics	11
Total	71

(CMM, 2016a). Participants took part in different knowledge transfer activities through conferences, training sessions, and discussion workshops. The Natural Infrastructure Summit attracted over 230 participants including environmental professionals, urban planners and informed citizens. Out of these participants, over 70 volunteered took part in focus groups (Table 1). All focus groups discussed four themes: 1) Design, development and enhancement of tools for green infrastructure; 2) Mobilization and participation of stakeholders; 3) Land use planning and green infrastructure development; 4) Resilience and climate change adaptation. Participants were broken into groups of 6 to 12 participants (referred to as FG-2) by the event organizers to balance the representation from different types of stakeholders: urban planners, city officials, civil servants, environmental NGOs, private sector organizations, graduate students and members of the public without affiliations. All groups discussed simultaneously for two sessions of 90 min, one on each day of the event. Focus group moderators, specialists on issues of GI, were chosen by event organizers, and a researcher was responsible for taking notes in each group. The discussion themes and questions had been jointly prepared in advance by researchers and planners. Those who took part in the focus group had received a participant's workbook that provided background on the themes and stated the questions for discussion (Annexe 0). The workbook content was framed in general terms and included the four themes specified previously.

The purpose of the focus group method is to generate qualitative data from discussions and interactions among participants (Creswell, 1998). Given the heterogeneity of each focus group, we were interested in how ideas would emerge and be challenged during a collective effort of deliberation within a group where multiple perspectives and values were represented. This method allows a focus on perceptions that are largely consensual, or at least predominant. The moderators had different backgrounds and levels of experience. However, as is the case with the focus group method, discussions were in some circumstances dominated by only a few more assertive individuals (Fern, 2001). However, the fact that most moderators were GI specialists in senior positions familiar with the focus group method, minimized this bias. Moreover, each moderator and the researcher in charge of taking notes were then involved in a debriefing session at the end of the event with the primary researchers, to share their respective understandings of what had been expressed in their focus groups.

The notes collected during the focus groups were consolidated into a single document of 115 pages in which all statements were anonymized, and the data pre-organized according to the themes addressed. We used content analysis to select and organize the main themes that arose from group discussions. More precisely, we relied on directed content analysis for coding – a code being a word or short sentence that refers to an important feature summing up a portion of text (Saldaña, 2013). We proceeded to basic coding based on themes in the literature and complemented the list of codes by allowing the emergence of new codes based on content originality and novelty, according to an inductive approach referred to as open coding (Hsieh and Shannon, 2005)

Table 2
Categories, codes and sub-codes used in content analysis.

Categories	Codes	Sub-codes
Potential for integrating green infrastructures within existing planning tools	Knowledge production tools	Ecosystem inventories
		Socioeconomic valuation
		Performance indicators
	Planning tools	Governance framework
		Legislative tools
		Harmonization of laws
		Municipal planning
Collaboration and public participation in the implementation of green infrastructures in planning processes	Collaboration between stakeholders	Cohabitation
		Civil society
		Dialog
		Representation
	Citizen mobilization	Knowledge diffusion
		Public consultations
		Education and awareness

*Connectivity, ecosystem diversity, stakeholder diversity.

(Table 2). Content analysis was performed through hand coding, in this case by reading the notes related to three focus groups selected randomly as a way to test our codes and identify new ones (Esterberg, 2002). All the qualitative data were coded according to the 2 categories: 1) Potential for the integration of green infrastructures within planning tools; 2) collaboration and public participation in the implementation of green infrastructures – which were broken down into 4 codes and 13 sub-codes identified through this process (Table 2).

5. Results

5.1. Potential for integrating green infrastructures within planning tools

5.1.1. Knowledge production tools for GI planning

The participants articulated narratives about the kind of knowledge that needs to be generated to achieve GI planning in the GMA. These statements indicate how the different stakeholders define GI, and how their views can influence planning practices and policies. Many participants, especially those active in the field of science and planning, spoke of a lack of knowledge on the state of natural environments on local ad reigonal scale in the GMA that was undermining GI implementation (FG-1-2). They defined knowledge as hard facts about ecosystems. However, most participants agreed that it is urgent to scale-up efforts and resources to enhance GI, even if some scientific data is lacking. Many stated that nothing should delay the efforts, due especially to what is already known about the state of degradation of ecosystems (FG-1; FG-2).

From the perspective of ecosystem protection and enhancement, the discussion about GI again elicited the idea that more data were necessary on the biodiversity and ecological functionality of specific sites, as well as the importance of each site within broader ecological networks in terms of connectivity (FG-1, 2). Researchers felt that effective biophysical indicators are required to determine the conservation priority status and to decide appropriate interventions and resource allocations (FG-2). On a different level, some insisted that what is insufficient is rather the knowledge about the specific needs and priorities of local human populations in terms of access to natural environments and the economic, cultural and recreational value of different sites (FG-1, 2). To reconcile biophysical and socioeconomic objectives, many participants believe that the economic evaluation of services provided by ecosystems – aesthetic, recreational, water and climate regulation,

agricultural production, etc. – is necessary to design effective planning interventions (FG-1, 2). In sum, many groups felt that existing planning standards, even if they were fully respected, are not sufficient to insure natural environment protection and enhancement. They argued for the need to develop better standards and criteria using more precise data on both natural ecosystems and socioeconomic and cultural systems (FG-1, 2).

Many participants insisted on the need to develop new indicators of environmental performance, at multiple scales and in accordance with the perspectives of all stakeholders (FG-1). Some groups recognized that the definition of performance is intrinsically a political process that must remain democratic (FG-1, 2). It was said by other participants that performance of GI should not only be measured in terms of biophysical criteria such as biodiversity, but also in consideration of social accessibility and community well-being (FG-2). In this regard, many perceive that GI planning will require in-depth information on the public's perceptions, and the possibility of harmonizing different purposes and functions such as environmental protection, recreational activities, conventional farming in peri-urban areas, forestry and education. Moreover, the participants argued that socioeconomic data should be integrated into planning to ensure that GI can contribute not only to a better distribution of ecosystem services across the metropolitan area, but also to environmental justice (FG-2). Some participants felt strongly that more knowledge is needed to develop indicators of conservation and urban quality. Many recognized that such indicators are important tools to translate priorities and targets regarding environmental conservation into an explicit language for urban planners and decision-makers (FG-1, 2). Yet, there was no consensus as to what kind of knowledge should be prioritized, and how to go about the planning of GI.

According to some stakeholders, for GI to become an object of coherent planning and policy in the GMA, and lead to the development of new knowledge development tools, ecosystem should be better known and measured, through different, more novel approaches such as ecological connectivity. Participants also emphasised, in addition or in opposition to knowledge on ecosystems, that socioeconomic features of the public were important for GI planning as well as to achieve a range of social and political objectives. As such, these data demonstrate different perceptions of how the concept of GI can influence knowledge production to improve ecosystem management in the GMA. Moreover, these results resonate with other studies that recognize the difficulties in defining and circumscribing GI to design effective planning tools (Matthews et al., 2015). As Lennon (2015a, 972) recognized, “disputes may emerge as to who possesses the correct professional expertise and institutional mandate legitimating participation in the formulation of GI policy”. This is reflected in the diverging ideas about the type of knowledge that should be developed to move forward with GI, and ultimately about the goals of such a planning approach.

5.1.2. Planning tools

The participants provided narratives about the regional governance framework provided by the Montreal Metropolitan Commission (MMC) and the Metropolitan Land Use Planning and Development Plan (PMAD) 2012–2017. Although this planning framework is largely perceived as a step forward in providing a governance structure for GI on a regional scale, the concept of GI and its normative components are not integrally part of the planning framework of the MMC. The MMC is a strategic planning structure at the scale of the GMA and acts as a steering body for regional scale governance. But many participants insisted that the fragmented nature of regional governance, especially when it comes to natural environment protection[3] (FG-2), remains a major obstacle to any regional scale GI planning. As such, municipalities are legally obliged to inscribe the MMC's natural environment protection targets in their official planning documents. However, participants expressed concerns, for example, that some rural municipalities within the MMC would lack the financial or organizational means to fully enforce the regulation pertaining to riverbank protection.[4] Many participants doubted that regional guidelines, standards and targets provided by the MMC could translate into socially and ecologically sound GI on a local level (FG-2).

Despite public consultations and feedback mechanisms that were part of creating the PMAD, many participants perceived the PMAD as too much of a top-down imposition of new standards and targets for natural environment protection. Many considered that targets and means to achieve them had been adopted without accounting for local context and resources (FG-2). On the other hand, some participants consider that MMC has limited political authority and resources to enforce GI governance on a regional scale, regardless of its political will to do so. In fact, the MMC has a relatively small budget based on the contribution of each municipality and does not have the power to levy taxes.[5] The relative weakness of this main regional governance body for the GMA was considered problematic for many, and they proposed a new mode of regional governance as the best way to integrate GI planning in governance structures (FG-2).

Participants in the focus groups suggested that there are existing laws that can be used to improve and enhance the protection of natural environments and further embed GI in policy and planning structures. However, what was pointed out in many focus groups was the perceived lack of harmonization and the limited application of the laws that include the most extensive provisions. Many discussions have pointed to the need to strengthen existing laws by the development of new policy or revising the legal framework around the notion of integrated natural environment planning at the regional scale, which is represented by the concept of GI as understood by most participants (FG-2).[6] Some groups discussed the possibility of increasing the scope of existing municipal planning tools such as provisions in planning documents that can be used by administrations to protect or set aside land with ecological value from development. However, the main narrative took into consideration the context of private property in which expropriation can seldom be considered appropriate to protect a natural environment permanently; a municipal administration often finds no alternative but to acquire properties. This can be prohibitively expensive both in terms of purchase price and land tax revenues forfeited. Participants lamented that there presently is little or no alternative to land purchase, and hence when it can be afforded acquisition is a dominant strategy among municipal administrations (FG-2).

In summary, these narratives about planning tools to implement GI in the GMA by stakeholders and professionals in planning state that the current governance framework has major limitations. Moreover, research participants perceive that mainstream legal tools and strategies are either partly ineffective or too costly to allow efficient implementation of GI planning. The main story-line emerging out of these discussions is an identification of current limitations in planning tools and their incompatibility with ecosystem management. These findings

[3] This is confirmed in a study on actor collaboration in water management in part of the GMA (Rathwell and Peterson, 2012).

[4] According to this protection policy, riparian buffers in cultivated areas should have a width of at least 3 m from the high water mark Protection Policy for Lakeshores, Riverbanks and Littoral Zones, Environment Quality Act, chapter Q-2, a. 2.1. (*Politique de protection des rives, du littoral et des plaines inondable*, *Loi sur la qualité de l'environnement, Loi sur la qualité de l'environnement*).

[5] The budget forecast for 2016 indicates a total budget of 126,000,000$CAN of which 25,000,000$CAN is dedicated to land acquisition and management by municipalities to improve green infrastructures, especially between two major poles of biodiversity (Oka and Mont-Saint-Hilaire) (CMM, 2016b).

[6] The provincial Bill on Sustainable Development (*Loi sur le développement durable, LDD*) exemplifies the problems related to different legislations that could be better implemented. Although the *LDD* provides 16 principles to guide actions in public administration at large, it does not include specific enforcement mechanisms for metropolitan areas, and remains external to most municipal decision-making processes.

are opposed to Rydin's (2010) who noted how stakeholders saw continuity between current planning practices and GI in a large european metropolitan area.

5.2. Collaborative and participatory processes to implement green infrastructures

5.2.1. Collaboration between stakeholders

Discussions about GI planning in the GMA elicited statements about the importance of collaboration between all stakeholders, and on the need to reach beyond formal governance structures. Participants felt that GI planning had to proceed in a collaborative manner, especially in the context of new and complex problems with unpredictable outcomes locally such as climate change and invasive species (FG-1). Participants perceived that sustained collaboration between stakeholders is needed to ensure that measures taken are effective, socially acceptable and that efforts and resources are fairly distributed (FG-1). Participants identified many processes of collaboration and dialog among stakeholders in the GMA, such as public consultations organized by municipalities or environmental organizations around planning issues.[7] However, many perceived that these collaborative processes only involve paid professionals and are not conducive to broad public participation (FG-1, 2). Moreover, most modes of collaboration would represent a silo approach to planning, as they only target a single sector of activity at the time (i.e. agriculture or water management), and do not provide an integrative framework (FG-2). Moreover, participatory approaches involving citizens at the local and regional scales were deemed essential to the success of GI initiatives according in a majority of participants, but still somewhat lacking in current policy frameworks (FG-2).

Many participants perceive that the agriculture sector, despite its importance for GI in the region (Fig. 1), remains largely outside collaborative initiatives (FG-2). Increasing collaboration between these sectors toward the development of GI appeared crucial to a large majority of participants (FG-2). For some, this could translate into a renewed focus on urban farming and community gardening in urban and peri-urban areas as a way of greening grey infrastructures (FG-2). However, many groups have criticized intensive agriculture as being one of the main sources of environmental degradation and pollution in the region, which would prevent more in-depth collaboration with other stakeholders (FG-2). Moreover, many groups discussed the utterly sectorial approach to the governance of environment in Quebec, such as farmland, forest and water management which are often dealt with in policies as separate fields of planning and intervention (FG-2).

Conciliation of uses and collaboration between stakeholders in agriculture, biodiversity conservation and recreation appeared as a major issue for a large majority of participants (FG-2). Some focus groups discussed the importance of knowledge transfer by research institutes regarding best practices in agriculture. They also emphasised how ecological innovations should be mainstreamed to improve environmental practices in the farming sector (FG-1, 2). Stakeholders in the focus groups suggested that farming practices in a perimeter around urban areas should be constrained by specific set of standards on environmental protection, and that new collaborative approaches should be proposed (FG-2).

The discussion about processes to implement GI elicited both normative and prescriptive statements among participants about the importance of collaboration and public participation. Moreover, the importance of integrating sectors perceived as being left out of the environmental planning framework was emphasised in the statements recorded. The silo approach to planning between different sectors of activity is mentioned as a problem by participants. This is also an aspect of environmental policy in Quebec that has been studied (Laroche and Olivier, 2015). Elsewhere, the challenges to forging collaboration between governance levels that align with socio-ecological processes is also well documented (Thomas and Littlewood, 2010; Faehnle et al., 2014). Moreover, discussions on GI planning revealed confrontational opinions about sectors of activity that would be responsible for environmental degradation. Narratives about processes to achieve GI planning highlight challenges to achieving collaboration in fragmented sectors and fields of intervention.

5.2.2. Mobilization and knowledge transfer

The narratives about GI by participants often raised the question of citizen engagement and participation. The discussions of many focus groups revolved around the question of public support for GI initiatives being necessary to exert pressure on municipal administrations to invest more resources in natural environment protection and enhancement. Hence many emphasised the importance of maintaining communication channels about natural environment management between citizens and elected officials. This is partly achieved in the GMA by environmental NGOs and civil society organizations, but could be further formalized at the regional scale. New efforts in collaboration would encourage citizen participation and social acceptability of certain environmental measures that are often less popular (FG-2). As one group discussed, measures such as urban densification to circumscribe urban sprawl on natural ecosystems are not always accepted by a majority of residents in low density housing sectors within the GMA. On the other hand, some participants recounted successful iterative consultations between municipal administrations and citizens that led to a more active role for citizens and allowed changing their perception (FG-2). Most participants agreed that projects conducive to improve environment planning targets can reach a high level of social acceptability if they are introduced through a public participation process.

Many participants believe that GI initiatives should be largely appropriated by citizen groups in a bottom-up fashion. According to some, the main challenge to achieve this would be to build a sense of belonging, an emotional connexion between citizens and the natural environment. Moreover, it was widely held that the general level of environmental awareness in a specific municipality has a major influence on ecosystem management choices. As expressed by some participants (FG-2), campaigns to raise awareness and educate citizens on the value of natural environments, foster the development of a common language that reflects a sense of attachment to natural environments. This would also require media attention focused on successful initiatives. Efforts to raise awareness among the public is deemed very important, especially when considering the limitations of control and command approaches (FG-2).

In the perspective of improving access to natural ecosystems on private lands for the public, many participants suggested that private forest owners should engage with citizen groups. Partnerships between citizen groups, environmental NGOs and land owners to share costs and responsibilities to improve public access and management of a forest parcel was cited as a way forward (FG-2). This would already be done through different legal mechanisms offered by environmental NGOs such as conservation easement on private land, which are also supported by municipal administrations. This can be achieved through formalized mutual agreements about the right of way between landowners and community-based organizations (FG-2). Participants mentioned agreement protocols to protect endangered species on private forests. Such approach has the potential to encourage a better distribution of costs and benefits related to forest management among different social groups and economic sectors. Moreover, this approach would foster applied collaboration between citizens, environmentalists and land owners (FG-2).

Overall, discussion about collaborative and participatory processes of GI planning elicits some perspectives on successful and innovative

[7] Examples of collaborative planning initiatives in place in Quebec: The Agricultural Zone Development Plan (*Plan de développement de la zone agricole - PDZA*); the Water Masterplan (*Plan directeur de l'eau*) developed at the scale of the watershed by watershed organizations (*organismes de bassins versants - OBV*)

approaches to mobilize citizens to take part in environmental management. In this regard, GI appears to be equated by research participants with new possibilities for improving public participation in natural environment protection and enhancement in a context dominated by private land tenure. This resonates with research that found that GI "implementation processes need to support openness, transparency in governance processes and legitimacy of knowledge from citizens, practitioners and policy stakeholders" (Raymond et al., 2017, 20). As such, the narratives from GMA stakeholders emphasise the importance of social processes based on deliberation for GI planning.

6. Discussion

The qualitative data presented in this study captures some of the narratives related to the obstacles and opportunities of GI implementation in the GMA by stakeholders involved in environment management and planning. The theory of discourse coalition provides a way to analyze the potential of GI to become a mainstream policy narrative with the power to influence planning policies and frameworks in the GMA. Although the GMA case is unique, these results resonate with reports from other metropolitan areas. Following Lennon (2015a, 2015b) who reviewed planning documents about GI in the USA, this research raises similar issues about which knowledge is useful to inform planning decisions on GI, and also which specific objectives should be pursued. In this regard, this research acknowledges that stakeholders perceive GI as an operative planning concept at the regional scale that has the potential to foster new participatory and collaborative approaches to environment management, and therefore resonates with the meta-analysis of Raymond et al. (2017) who came to similar conclusions. This study also points to the generality of the GI concept, which leaves open the opportunity to form a discourse coalition around multiple objectives, without necessarily translating those objectives immediately into concrete change in practices (Hajer, 1995, p. 14 cited by Lennon, 2015a).

In the GMA, as in other cases in Europe and North America, many stakeholders in urban planning and environment perceive that one of the main challenge remains better defining and prioritizing interventions related to environment planning in urban areas according to the concept of GI (Čivić and Jones-Walters, 2014; Matthews et al., 2015; Raymond et al., 2017). Alternatively, according to Wright (2011), the definition of GI is inherently dynamic and depends on the groups or administrations to adapt it in specific circumstances. Put in another way, the concept of GI is intrinsically polysemic and contested (Fletcher et al., 2015), which is a strength in adaptation to local circumstance but a weakness in moving quickly to an effective storyline. This study suggests that multiple discourses about the role of GI in the GMA are in play, and no single way forward is yet clear. As is the case generally, the present lack of consensus on the best approaches related to GI derives from the variety of objectives that can be given priority, by the large number of stakeholders, and by institutional frameworks involved (Hostetler et al., 2011; Naumann et al., 2011; Roe and Mell, 2013). Developing an effective narrative about the integration of GI within existing planning processes remains one of the main issues in most metropolitan areas (Matthews et al., 2015).

Perhaps the greatest obstacle to developing a coherent narrative for integrating GI into planning within the GMA is better harmonization of laws within the overlapping levels of governance; there presently are too many levels of weakly coordinated institutional structures in the legislative frameworks that bear on GI planning. According to workshop participants and in accord with research on environmental governance (Rathwell and Peterson, 2012), municipal administrative frameworks in the GMA are especially ineffectual with regard to some aspects of environmental regulation. Nonetheless, stakeholder insights into ways to improve current planning tools and practices suggest the possibility for planning processes consistent with a social and ecological understanding of GI (Folke et al., 2002). The GI concept in the GMA, as elsewhere, provides a normative dimension that allows taking into consideration interactions between socioecological processes and structures of governance as demonstrated for different urban areas (Faehnle et al., 2014; Pellegrino et al., 2014).

According to the stakeholders consulted, the prospect for a discourse coalition to emerge around the concept of GI in the GMA remains difficult to assess at this early stage. Most participants considered a GI perspective as a benchmark for any critique of current frameworks and practices, and for any innovative approaches to multifunctional green space at the regional scale. The GI concept clearly was associated with a comprehensive understanding of environmental management at the scale of the GMA, but the outlines for a normative and prescriptive narrative that would satisfy diverging interests and values did not emerge. Moreover, there was indication that stakeholders felt that planning and implementation of GI is largely perceived as an issue of environmental justice (Wolch et al., 2014). The concern for environmental justice arose in different narratives about GI in the GMA, especially with regard to defining the necessary breadth of participatory approaches. Narratives emphasised the need for a better distribution of benefits and costs related to ecosystem management between areas and sectors, notably through improved collaboration. As such, definition of acceptable objectives and targets in terms of GI planning was expressed by many participants as a social process of collaboration.

7. Conclusion

This study of narratives about opportunities and obstacles related the GI planning in the GMA shows that most participants do not consider the improvement of GI primarily as a technical issue, but instead insisted on the social collaboration and learning processes underlying GI design and implementation. Although it remains difficult to assess the potential for a discourse coalition to form around GI, a prominent narrative was related to the need for ongoing collaboration between economic sectors and groups of actors such as urban planners, citizens, environmental NGOs and private land owners. Moreover, an important number of participants expressed the view that sustained collaboration depends on public engagement both locally and at the regional scale. In sum, further participatory discussion of the GI concept may lead to the emergence of an effective discourse coalition in the GMA to foster collaborative environmental governance at the regional scale.

To move forward with GI in the GMA, according to the theory of discourse coalition, a discourse based on a specific operative definition of GI would have to gain rhetorical power to influence planning policy and practices. The prospect of such discourse would have to get beyond what many participants perceive as the current protection of natural spaces in a piecemeal fashion. As such, in the GMA, among the stakeholders in these initial discussions, the GI concept is recognized as essential for any coherent approach to enhance ecosystem services at the scale of the metropolitan area. Participants accepted GI as a useful point of reference for assessing current planning and legislative tools and when proposing ways to integrate diverse sources of knowledge in the definition of GI objectives. Although many participants were critical of current regional environment governance in the GMA, opinions diverged regarding the means best suited to achieve regional-scale GI implementation. Echoing some of the results presented elsewhere (Lennon, 2015a; Roe and Mell, 2013), deliberation among a broad base of actors and stakeholders is required to better integrate a plurality of perspectives and knowledge at different scales in GI planning.

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Annexe 1. Discussion questions for focus groups at the Summit on Green Infrastructure for Greater Montreal

Theme # 1: Design, development and enhancement of tools for green infrastructures/*Outils de conception, mise en œuvre, de valorisation des infrastructures vertes*

- What are the legal, urbanism, financial and fiscal tools that will allow to better protect and promote green infrastructures in Greater Montreal? What are the main limitations of these tools? Should new tools be developed? *Quels outils d'ordre légal, urbanistique, financier et fiscal permettent de mieux protéger et mettre en valeur les infrastructures naturelles du Grand Montréal? Quelles sont les principales limites de ces outils? De nouveaux outils devraient-ils être développés?*
- What planning criteria can be used to protect and enhance natural environments? What are other criteria that could be implemented? *Quels critères d'aménagement peuvent servir à des fins de protection et de mise en valeur des milieux naturels? Quels autres critères pourrait-on mettre en place?*
- What municipal fiscal tools are most adapted to the protection and enhancement of green infrastructure? What are some of the backlashes to be concerned about? *Quels outils fiscaux municipaux sont les mieux adaptés à la protection et à la valorisation des infrastructures vertes? Quels effets rebonds faut-il redouter?*
- What are complementary options for land acquisition to achieve conservation objectives? *Quelle sont les autres options complémentaires à l'acquisition de terrains à des fins de conservation?*

Theme # 2: Mobilization and participation of stakeholders in green infrastructures/*Mobilisation et concertation des différents intervenants*

- What are the stakeholders to be mobilized for the protection and enhancement of natural environments in Greater Montreal? How to insure mobilization and participation of most stakeholders? *Quelles sont les parties prenantes pour la protection et de la mise en valeur des milieux naturels du Grand Montréal? Comment favoriser la mobilisation et la concertation de l'ensemble de ces parties prenantes?*
- What are the agencies and authorities currently in place to insure adequate mobilization and participation? *Quelles sont les instances actuellement en place qui font office de lieux de concertation et de mobilisation?*
- What are the different approaches allowing to involve citizens into a process of conservation and enhancement of natural environments? *Quel sont les différentes approches permettant d'associer les citoyens à une démarche de conservation et de valorisation des milieux naturels?*
- What are the main reference documents regarding protection and enhancement of green infrastructures? Is the Metropolitan Land Use Planning and Development Plan (PMAD) part of these reference documents? *the Quels sont les principaux documents de référence en matière de protection et de mise en valeur des infrastructures naturelles? Est-ce que le PMAD fait partie de ces documents de référence?*
- How to gather stakeholders (researchers, civil society, NGOs, elected officials, professionals, etc.) around structural projects that go beyond administrative boundaries to improve green infrastructure planning? *Comment rassembler les acteurs* (*chercheurs, société civile, organismes, élus, professionnels,* etc.) *autour de projets structurants qui dépassent les frontières administratives pour une meilleure planification des infrastructures naturelles?*
- How to ensure that university research done on protection and enhancement of green infrastructures can become accessible to users and decision makers? *Comment s'assurer que la recherche universitaire effectuée quant à la protection et mise en valeur des infrastructures naturelles trouve son chemin auprès des utilisateurs et décideurs?*
- How to reach negotiated solutions that reconcile the spheres of economy, environment and society and rally a majority when time comes to protect and enhance green infrastructures? *Comment arriver à des solutions négociées, qui concilient des impératifs économiques, environnementaux et sociaux et qui rallient une majorité lorsque vient le temps de mettre en valeur et protéger les infrastructures vertes?*

Theme # 3: Land use planning and green infrastructure development/*Aménagement du territoire et développement des infrastructures vertes*

- How to reconcile protection and enhancement objectives for greeninfrastructures with population growth figures for Montreal? *Comment concilier des objectifs de protection et de mise en valeur des infrastructures vertes avec la croissance projetée du Grand Montréal?*
- How to reconcile these objectives in agricultural sectors? *Comment concilier ces objectifs en milieu agricole?*
- How to encourage and promote sustainable natural environment resource use while respecting conservation, restauration and accessibility criteria? *Comment encourager et favoriser l'utilisation durable des ressources des milieux naturels et respectant des critères de conservation, de restauration et d'accessibilité?*
- How to improve the access to natural environments located outside the existing network of parks and protected areas? *Comment améliorer l'accessibilité aux milieux naturels qui n'appartiennent pas au réseau des parcs et milieux protégés ouverts au public?*
- What are the constraints to improving cohabitation of different functions (conservation, education, farming, forestry, etc.) of natural environments? *Quelles sont les contraintes à une meilleure conciliation des différentes fonctions* (*conservation, éducation, production agricole, foresterie,* etc.) *des milieux naturels?*

Theme # 4: Resilience and climate change adaptation/*Résilience et adaptation aux changements climatiques*

- What are the effects of climate change that are expected at the scale of the Greater Montreal and how is the environment vulnerable to these

effects? *Quels sont les impacts appréhendés des changements climatiques à l'échelle de la région métropolitaine de Montréal et quelle est la vulnérabilité du milieu face à ces impacts?*

- How to insure complementarity between green infrastructures and traditional infrastructures to improve ecosystem and community resilience toward climate change? *Comment assurer la complémentarité entre les infrastructures naturelles et les infrastructures traditionnelles pour renforcer la résilience des écosystèmes et des communautés face aux changements climatiques?*
- How to plan a green infrastructure network that is integrated geographically and well planned over time to answer the needs of the region for the next 10, 20 or 30 years to come? *Comment planifier un réseau d'infrastructures naturelles qui soit intégré au plan géographique et planifié dans le temps pour répondre aux besoins de la région dans 10, 20 ou 30 ans?*
- What are the priority measures regarding the planning of natural infrastructures in order to adapt to climate change? *Quelles sont les mesures prioritaires en matière d'aménagement des infrastructures vertes et bleues pour s'adapter aux changements climatiques?*
- How to bring into line local measures regarding adaptation and mitigation of climate change to other policies and regulations, actions plans at the regional scale? *Comment arrimer les mesures prises localement concernant l'adaptation et l'atténuation des changements climatiques aux autres politiques, règlementations, plan d'action à l'échelle de la région métropolitaine?*

Annexe 2

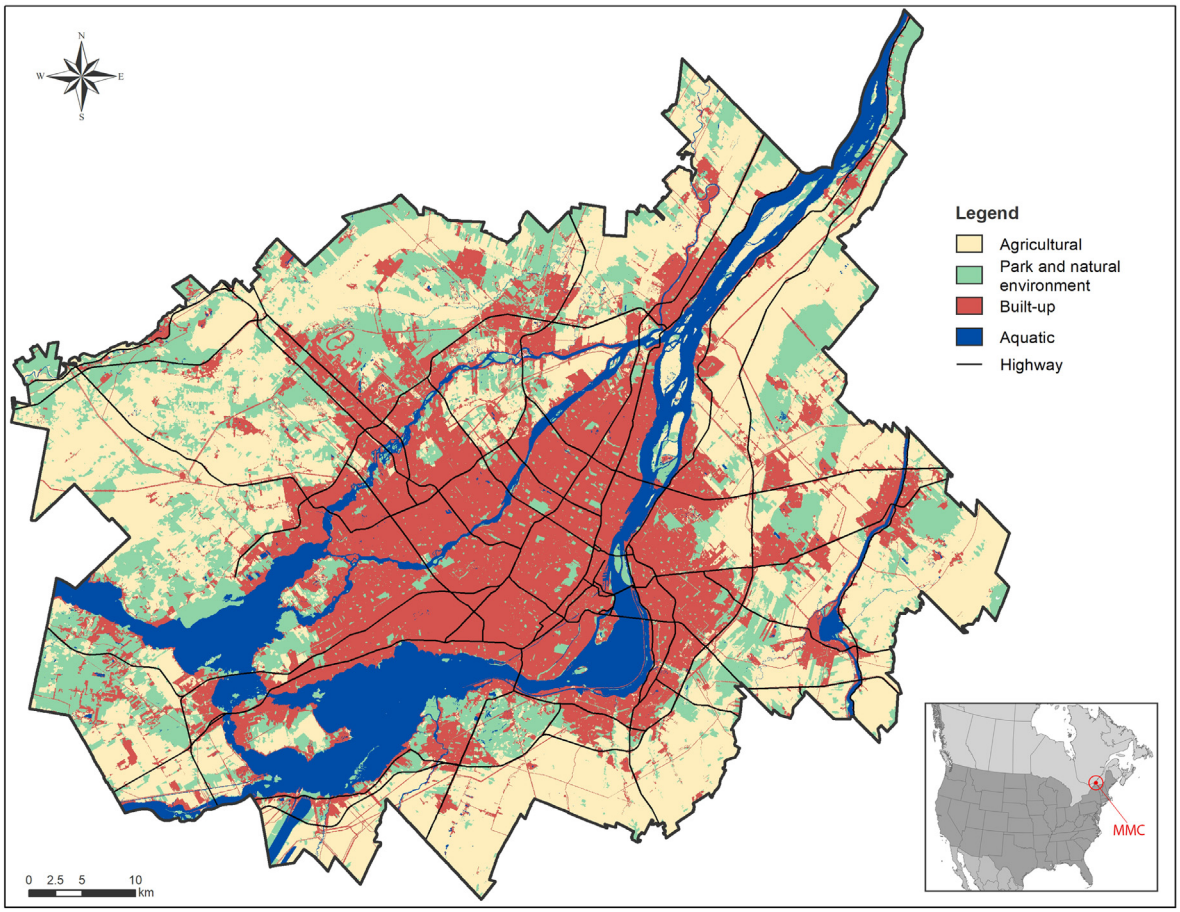

Fig. 1. Main land use classes and bodies of water in the 82 municipalities that comprise the Montreal Metropolitan Community.
Land use, 2015, Gouvernement du Québec, Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC); Montreal Metropolitan Community administrative boundaries, CMM, PMAD, decembre 2011; Road network, CMM, PMAD, decembre 2011; North america states and provinces, 2009, Made with Natural Earth

References

Ahern, J. (2013). Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design. *Landscape Ecology, 28*(6), 1203–1212.

Allmendinger, P. (2017). *Planning theory*. London: Palgrave Mcmillan.

Amati, M., & Taylor, L. (2010). From green belts to green infrastructure. *Planning Practice & Research, 25*(2), 143–155.

Attoe, W., & Logan, D. (1989). *American urban architecture: Catalysts in the design of cities*. Univ of California Press.

Baptiste, A. K., Foley, C., & Smardon, R. (2015). Understanding urban neighborhood differences in willingness to implement green infrastructure measures: A case study of Syracuse, NY. *Landscape and Urban Planning, 136*, 1–12.

Beaudin, L. (2003). *Problématique de la disparition et de la fragmentation des boisés privés en milieu agricole. Mémoire présenté à la commission sur le développement durable de la production porcine au Québec. Ministère des affaires municipales et de la métropole.* (12 pages).

Bélanger, L., & Grenier, M. (2002). Agriculture intensification and forest fragmentation in the St. Lawrence valley, Québec, Canada. *Landscape Ecology, 17*, 495–507.

Benedict, M. A., & McMahon, E. T. (2006). *Green infrastructure: Smart conservation for the 21st century*. Washington D.C.: Sprawl Watch Clearinghouse.

Bissonnette, J. F., Dupras, J., & Blouin, D. (2017). *Comment favoriser les infrastructures naturelles dans le Grand Montréal. Une analyse des opportunités et contraintes relatives à leur développement.* Fondation David Suzuki, CSBQ, ISFORT.

Bissonnette, J. F., Dupras, J., Doyon, F., Chion, C., & Tardif, J. (2016). Perceptions of small private forest owner's vulnerability and adaptive capacity to environmental disturbances and climate change: Views from a heterogeneous population in southern

Quebec, Canada. *Small-scale Forestry,* 1–27.
Boudreau, J.-A., Hamel, P., Jouve, B., & Keil, R. (2006). Comparing metropolitan governance: The cases of Montreal and Toronto. *Progress in Planning, 66*(1), 7–59.
Byrne, J. A., Lo, A. Y., & Yang, J. J. (2015). Residents' understanding of the role of green infrastructure for climate change adaptation in Hangzhou, China. *Landscape and Urban Planning, 138*, 132–143.
Čivić, K., & Jones-Walters, L. M. (2014). Implementing green infrastructure and ecological networks in Europe: Lessons learned and future perspectives. *Journal of Green Engineering, 4*(4), 307–324.
Communauté métropolitaine de Montréal (CMM) (2011). *Plan métropolitaine d'aménagement et de développement de Montréal.* Montréal. (cmm.qc.ca/fileadmin/user_upload/pmad2012/documentation/20120530_PMAD.pdf).
Communauté métropolitaine de Montréal (CMM) (2013). Identification et protection des bois et des corridors forestiers métropolitains. http://www.cmm.qc.ca/fileadmin/user_upload/documents/fascicule_boisCorridors_web.pdf.
Communauté métropolitaine de Montréal (CMM) (2015). *Projections démographiques: 221 000 nouveaux ménages attendus dans le Grand Montréal pour la période 2016–2031.* Bulletin de la Communauté métropolitaine de Montréal (Novembre 2015).
Communauté métropolitaine de Montréal (CMM) (2016a). *Sommet sur les infrastructures naturelles du Grand Montréal. Cahier du participant.* (16-17 juin 2016).
Communauté métropolitaine de Montréal (CMM) (2016b). Prévisions budgétaires 2016. http://cmm.qc.ca/fr/a-propos/budget-et-finances/.
Communauté métropolitaine de Montréal (CMM) (2016c). Plan d'action métropolitain de mise en valeur du territoire et des activités agricoles. 2016–2020 http://cmm.qc.ca/champs-intervention/amenagement/dossiers-en-amenagement/agriculture/.
Cowell, R., & Lennon, M. (2014). The utilisation of environmental knowledge in land-use planning: Drawing lessons for an ecosystem services approach. *Environment and Planning C: Government and Policy, 32*(2), 263–282.
Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, Calif.: Sage.
David-Suzuki Foundation, & Nature Action Québec (2012). *Une ceinture verte grandeur nature : un grand projet mobilisateur pour la région de Montréal.* (Montréal. 49 pages).
Di Marino, M., & Lapintie, K. (2017). Exploring the concept of green infrastructure in urban landscape. Experiences from Italy, Canada and Finland. *Landscape Research.* http://dx.doi.org/10.1080/01426397.2017.1300640.
Doyon, F., Bouchard, A., & Gagnon, D. (1998). Tree productivity and successional status in Québec northern hardwoods. *Ecoscience, 5*(2), 222–231.
Dupras, J., & Alam, M. (2015). Urban sprawl and ecosystem services: A half century perspective in the Montreal area (Quebec, Canada). *Journal of Environmental Policy & Planning, 17*(2), 180–200.
Dupras, J., Drouin, C., André, P., & Gonzalez, A. (2015). Towards the establishment of a green infrastructure in the region of Montréal (Quebec, Canada). *Planning Practice & Research, 30*(4), 355–375.
Dupras, J., Marull, J., Parcerisas, L., Coll, L., Gonzalez, A., Girard, M., & Tello, E. (2016). The impacts of urban sprawl on ecological connectivity in the Montreal Metropolitan Region. *Environmental Science & Policy, 58*, 61–73.
Emmanuel, R., & Loconsole, A. (2015). Green infrastructure as an adaptation approach to tackling urban overheating in the Glasgow Clyde Valley Region, UK. *Landscape and Urban Planning, 138*, 71–86.
Erixon, H., Borgström, S., & Andersson, E. (2013). Challenging dichotomies–exploring resilience as an integrative and operative conceptual framework for large-scale urban green structures. *Planning Theory & Practice, 14*(3), 349–372.
Esterberg, K. G. (2002). *Qualitative methods in social research.* Columbus, OH: McGraw-Hill.
Evans, C., & Freestone, R. (2010). From green belt to green web: Regional open space planning in Sydney, 1948–1963. *Planning Practice & Research, 25*(2), 223–240.
Faehnle, M., Bäcklund, P., Tyrväinen, L., Niemelä, J., & Yli-Pelkonen, V. (2014). How can residents' experiences inform planning of urban green infrastructure? Case Finland. *Landscape and Urban Planning, 130*, 171–183.
Fern, E. F. (2001). *Advanced focus group research.* Thousand Oaks, Calif: Sage.
Fischer, F. (2003). *Reframing public policy: Discursive politics and deliberative practices.* New York: Oxford University Press.
Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., ... Mikkelsen, P. S. (2015). SUDS, LID, BMPs, WSUD and more–the evolution and application of terminology surrounding urban drainage. *Urban Water Journal, 12*(7), 525–542.
Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio: A Journal of the Human Environment, 31*(5), 437–440.
Goldstein, P. Z. (1999). Functional ecosystems and biodiversity buzzwords. *Conservation Biology, 13*, 247–255.
Hajer, M. (1993). Discourse coalitions and the institutionalisation of practice: The case of acid rain in Great Britain. *Fischer, Frank/Forester, John (Hrsg.): The argumentative turn in policy analysis and planning* (Durham/London. S. 43–67).
Hajer, M. A. (1995). *The politics of environmental discourse: Ecological modernization and the policy process.* Oxford: Clarendon Press.
Horwood, K. (2011). Green infrastructure: Reconciling urban green space and regional economic development: Lessons learnt from experience in England's north-west region. *Local Environment, 16*(10), 963–975.
Hostetler, M., Allen, W., & Meurk, C. (2011). Conserving urban biodiversity? Creating green infrastructure is only the first step. *Landscape and Urban Planning, 100*(4), 369–371.
Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288.
Jaeger, J. A. G., & Nazarnia, N. (2016). Social and ecological impacts of the exponential increase of urban sprawl in Montréal. *Canada Communicable Disease Report, 42*(10), 207.
Kati, V., & Jari, N. (2016). Bottom-up thinking-identifying socio-cultural values of ecosystem services in local blue-green infrastructure planning in Helsinki, Finland. *Land Use Policy, 50*, 537–547.
Laroche, G., & Olivier, A. (2015). Contexte politique québécois et pratique de l'agroforesterie: État des lieux. *The Forestry Chronicle, 91*(5), 524–533.
Lennon, M. (2015a). Green infrastructure and planning policy: A critical assessment. *Local Environment, 20*(8), 957–980.
Lennon, M. (2015b). Explaining the currency of novel policy concepts: learning from green infrastructure planning. *Environment and Planning C: Government and Policy, 33*(5), 1039–1057.
Lovell, S. T., & Taylor, J. R. (2013). Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landscape Ecology, 28*(8), 1447–1463.
Mabelisa, A. A., & Maksymiukb, G. (2009). Public participation in green urban policy: Two strategies compared. *International Journal of Biodiversity Science and Management, 5*(2), 63–75.
Madureira, H., & Andresen, T. (2014). Planning for multifunctional urban green infrastructures: Promises and challenges. *Urban Design International, 19*(1), 38–49.
Matthews, T., Lo, A. Y., & Byrne, J. A. (2015). Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning, 138*, 155–163.
Meilleur, A., Bouchard, A., & Bergeron, Y. (1994). The relation between geomorphology and forest community types of the Haut-Saint-Laurent, Quebec. *Plant Ecology, 111*(2), 173–192.
Naumann, S., Davis, M., Kaphengst, T., Pieterse, M., & Rayment, M. (2011). *Design, implementation and cost elements of green infrastructure projects. Final report. 138*. Brussels: European Commission.
Nazarnia, N., Schwick, C., & Jaeger, J. A. (2016). Accelerated urban sprawl in Montreal, Quebec City, and Zurich: Investigating the differences using time series 1951–2011. *Ecological Indicators, 60*, 1229–1251.
Pan, D., Domon, G., De Blois, S., & Bouchard, A. (1999). Temporal (1958–1993) and spatial patterns of land use changes in Haut-Saint-Laurent (Quebec, Canada) and their relation to landscape physical attributes. *Landscape Ecology, 14*(1), 35–52.
Pellegrino, P., Ahern, J., & Becker, N. (2014). Green infrastructure: Performance, appearance, economy, and working method. *Revising green infrastructure: Concepts between nature and design* (pp. 385–404). CRC Press.
Rathwell, K. J., & Peterson, G. D. (2012). Connecting social networks with ecosystem services for watershed governance: A social ecological network perspective highlights the critical role of bridging organizations. *Ecology & Society, 17*(2), 24.
Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., ... Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science and Policy, 77*, 15–24.
Roe, M., & Mell, I. (2013). Negotiating value and priorities: Evaluating the demands of green infrastructure development. *Journal of Environmental Planning and Management, 56*(5), 650–673.
Rydin, Y. (2010). *Governing for sustainable urban development.* London: Earthscan.
Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). London, UK: Sage Publications.
Sandström, U. F. (2002). Green infrastructure planning in urban Sweden. *Planning Practice and Research, 17*(4), 373–385.
Shapiro, M. (1981). *Language and political understanding: The politics of discursive practice.* New Haven, CT: Yale University Press.
Simard, H., & Bouchard, A. (1996). The precolonial 19th century forest of the Upper St. Lawrence Region of Quebec; a record of its exploitation and transformation through notary deeds of wood sales. *Canadian Journal of Forest Research, 26*(9), 1670–1676.
Sokpoh, K. (2010). *Portrait des pertes de superficies forestières en Montérégie entre 2004 et 2009.* Agence forestière de Montérégie, Geomont.
Taylor, J., Paine, C., & FitzGibbon, J. (1995). From greenbelt to greenways: Four Canadian case studies. *Landscape and Urban Planning, 33*(1), 47–64.
Thomas, K., & Littlewood, S. (2010). From green belts to green infrastructure? The evolution of a new concept in the emerging soft governance of spatial strategies. *Planning Practice & Research, 25*(2), 203–222.
Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. *Landscape and Urban Planning, 81*(3), 167–178.
Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning, 125*, 234–244.
Wright, H. (2011). Understanding green infrastructure: The development of a contested concept in England. *Local Environment, 16*(10), 1003–1019.
Yokohari, M., Takeuchi, K., Watanabe, T., & Yokota, S. (2000). Beyond greenbelts and zoning: A new planning concept for the environment of Asian mega-cities. *Landscape and Urban Planning, 47*(3), 159–171.
Young, R. F., & McPherson, E. G. (2013). Governing metropolitan green infrastructure in the United States. *Landscape and Urban Planning, 109*(1), 67–75.